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THE AMERICAN METEOROLOGICAL JOURNAL.

A MONTHLY REVIEW OF METEOROLOGY.

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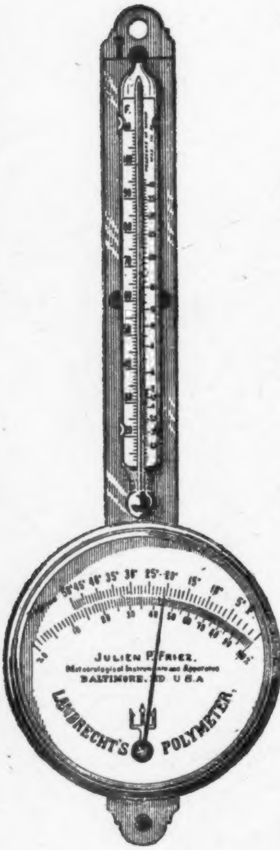

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THE AMERICAN

METEOROLOGICAL JOURNAL.

VOL. XII. BOSTON, MASS., AUGUST, 1895. No. 4.

EDITORIAL NOTES.

THE removal by President Cleveland of Prof. Harrington from his position as Chief of the United States Weather Bureau, which occurred July 1, while deeply to be regretted, was not altogether unexpected by those familiar with the unpleasant relations which have existed between Prof. Harrington and Mr. Morton since the latter became Secretary of Agriculture, and whose termination cannot fail to be in the nature of a relief to Prof. Harrington.

It appears proper at this time and in this JOURNAL to review briefly Prof. Harrington's successful efforts to improve the Weather Bureau. When that institution, which, from its organization in 1870, had formed part of the United States Army Signal Service, was separated from the War Department, in 1890, and made a civil bureau in the Agricultural Department, it gave the greatest satisfaction to scientific men in this country as well as abroad, and this feeling was intensified when Prof. Mark W. Harrington was appointed Chief of the Weather Bureau under Gen. Rusk, then Secretary of Agriculture, for Prof. Harrington who was then professor of astronomy and director of the Observatory at the University of Michigan, was well known to meteorologists as an earnest student and as the founder and editor of this JOURNAL. (A sketch of his life will be found on page 126, Vol. VIII., of this JOURNAL.)

Prof. Harrington assumed office on July 1, 1891, prepared to introduce scientific methods, and to favor appointments dependent on merit in a bureau where hitherto no fixed policy of research had prevailed, and which had been governed by mili-

tary regulations. This was the more incongruous, in view of the fact that in none of the military despotisms of Europe are the Weather Services thus controlled. Some of the important changes made by Prof. Harrington were as follows: —

In July, 1891, the system of local forecasts was commenced. Up to that time forecasts had been made at Washington for all parts of the country, but the favorable reception of the private forecasts made at the Blue Hill Observatory led to the appointment of twenty local forecast officials in various parts of the country. In 1893 the flood predictions were also intrusted to them, while continuous practice work by all forecasters, and competitions for filling the professorships at Washington with accomplished forecasters, were introduced. In this way the practical objects for which the Bureau was created were well provided for, but, in addition, research, which might ultimately or indirectly benefit the work in hand, was prosecuted so far as the small appropriations applicable to this end would allow. These researches included, among other topics, a special investigation of the currents of the Great Lakes, and a systematic study of thunderstorms, which were published with other memoirs, in a series of Weather Bureau Bulletins.

The work of Profs. Abbe, Bigelow, and Barus, along scientific lines, has furnished very valuable matter for publication, and has done much to give our Weather Bureau a high position among the Weather Services of the World.

The international form of publication for the observations which had been generally adopted throughout the world was first used for the Weather Bureau data of 1891, and the first meeting of the American Association of State Weather Services, held the next year, helped to bring the work of these bureaus in closer conformity with that of the National Government.

Notwithstanding the increased routine work executed by Prof. Harrington, the cost of it was less than the expenditures of his predecessors, Generals Hazen and Greely. Thus, from a recently published statement, it appears that the average cost of maintenance of the meteorological work of the Signal Service for the ten years preceding its transfer to the Weather Bureau was $924,660, while during the four years of civil administration the average cost has been only $849,522. More work has been done under the last *régime*. For example, in 1887, the total

number of weather maps and crop bulletins issued was 181,500 which was increased to 1,237,000 in 1891, the last year of military control. In 1892, the first year of civil rule, 1,860,000 maps were issued, while during the past year this total was about 3,738,000.

This statement of more information given to the public at a less cost appeals to our citizens, and foreign expert opinions of the Weather Bureau under Prof. Harrington is shown by the fact that in 1891 the United States, for the first time, was represented in the International Meteorological Committee by the election of Prof. Harrington as a member of that body.

The deposition of Prof. Harrington is felt with special regret by the editors of this JOURNAL, for it was largely by his work in founding and editing this magazine and by his contributions to its pages, that he became well-known to foreign meteorologists, whose lively interest in and appreciation of his work have given him a reputation for scientific training which few other meteorologists in this country possess.

In view of the facts demonstrating the growing efficiency and the increasing reputation of the Weather Bureau at home and abroad it must appear that the removal of its Chief found a cause either in politics or in personal enmity.

THE readers of the JOURNAL will be pleased to note the addition of the name of Mr. Oliver L. Fassig to our list of associate editors. Mr. Fassig's regular contributions to this JOURNAL have enabled us to print complete lists of the titles of recent publications from month to month, in this way greatly increasing the value of the magazine to those who wish to keep informed of the new publications that are being issued in such large numbers. As an associate editor Mr. Fassig will contribute bibliographical and other notes to a greater extent than heretofore, his position as librarian of the Weather Bureau in Washington giving him the best possible opportunity to furnish the JOURNAL with such information as will be of interest and value to its readers.

RELATION OF CLOUDS TO RAINFALL.*

H. HELM CLAYTON.

DURING 1887 and 1888 hourly cloud observations were taken at Blue Hill Meteorological Observatory with few omissions for 16 hours of each day between 7 A. M. and 11 P. M.

To study the succession of cloud forms and their changes, preceding, during, and following rain, all the periods of rainfall during these two years were selected. Beginning with the first entirely cloudless interval preceding each rain and using the international nomenclature, the successive cloud forms observed were jotted down in the order of their appearance and disappearance until the sky was cloudless again after the rain. In each case the number of hours the first cloud preceded the rain and the last cloud disappeared after the rain was also noted. In many cases the clouds did not disappear entirely between the intervals of rain. In these cases when the intervals of rain were less than a day apart they were considered as belonging to the same storm, but if more than a day apart, were considered as separate storms, and the succession of clouds was begun and ended with the time of minimum cloudiness, or with the first appearance of upper clouds. In jotting down the succession of cloud forms the fracto-cumulus when they appeared shortly before noon and disappeared during the afternoon were not considered, as they are evidently a diurnal phenomenon, independent of the storm.

After jotting down the observations in this manner they were compared, and all which appeared similar were classed under the same head. It was found that in many storms only a single stratum of clouds preceded or followed the rain; while in others two, three, four, or five were distinguished. The first classification was based on this difference. In the cases with the single cloud stratum the highest clouds observed invariably appeared first and, growing by degrees denser, appeared as lower

* Prepared at Blue Hill Meteorological Observatory for publication in the Annals of Harvard College Astronomical Observatory, and read before the New England Meteorological Society, May 6, 1895. Published by permission of Mr. Rotch.

and lower cloud forms until rain began. In the cases of two or more strata, the higher clouds, with few exceptions, appeared first, and lower strata appeared successively beneath as the rain approached. There were eight cases in all in which cirrus or cirro-cumulus appeared later than lower clouds and were observed for short intervals in small patches above a sheet of alto-cumulus or broken alto-stratus.

There were 69 rains preceded by a single cloud stratum, 46 preceded by two strata, 15 by three strata, and 5 by four strata. In the intervals between rain when the lower clouds broke, there were 27 cases in which two strata of clouds were visible, 9 cases in which three strata were visible, and two cases in which the lower clouds cleared away entirely for a while, leaving only a single stratum of upper clouds visible. Following rain there were 36 cases in which a single cloud stratum was observed, 60 cases in which two strata were observed, 10 cases in which three strata were observed, and 4 cases in which four strata were observed, from which it follows that the most frequent condition is a single stratum of clouds preceding rain and a double stratum following rain.

After separating the clouds in accordance with the number of strata observed, those cases in which the succession of cloud forms as the same or nearly the same were classed together.

It was found that the most frequent succession of clouds preceding rain was cirrus, cirro-stratus, alto-stratus, and nimbus, gradually merging into each other in the same stratum, or these forms changing into and alternating with cirro-cumulus and alto-cumulus and followed by nimbus. In these cases rain begins to fall from a high sheet of cloud (*alto-nimbus*), which rapidly grows lower and develops into the ordinary low, dark, ragged sheet of nimbus, whose base is less than one thousand meters above the earth's surface, and frequently less than one hundred meters.

The first cloud which appeared in advance of the rain was usually cirrus. In one case the overspreading of the sky by a whitish haze gradually developing into cirro-stratus without the appearance of cirrus was observed; in three cases cirro-cumulus and alto-cumulus were the first clouds to appear, and in two other cases the sky was gradually covered by lower clouds without any upper clouds being seen. In the cases where two or more strata were observed, the succession of higher clouds

was in the main the same as with one stratum. Cirrus and cirro-stratus first appeared, and later cirro-cumulus, alto-cumulus, or alto-stratus appeared beneath these, or later still, strato-cumulus, cumulus, or fracto-nimbus appeared at a still lower level. As a rule, the lower the cloud the later its appearance. The formation of small cumulus near the middle of the day, as stated before, was not considered.

Rain was observed to fall from four classes of cloud, namely: (1) a high cloud sheet (*alto-nimbus*), usually smooth and continuous at an average elevation of about 2,000 meters, and frequently having fracto-nimbus or scud drifting beneath; (2) a low, ragged cloud sheet (nimbus), at an average altitude of about 700 meters; (3) long, low rolls of cloud, giving light intermittent showers at an average elevation of about 1,000 meters; and (4) a towering cloud of the cumulus type (cumulo-nimbus), at an average altitude of about 1,400 meters for its base and 6,000 to 8,000 meters for its top.

Between intervals of rain, when the lower clouds broke, two levels of clouds were usually visible, generally cirro-cumulus or alto-cumulus above, and fracto-nimbus or strato-cumulus below. Sometimes three levels were visible, a high, a middle, and a low level, in which the flock clouds, cirro-cumulus, alto-cumulus, and strato-cumulus were most frequently visible.

Following rain, the most frequent clouds were strato-cumulus, usually in long, low rolls at an altitude of about 1,000 meters, while above these was most frequently cirrus or cirro-stratus.

To determine how many times each cloud form was visible preceding, during, and following rain, they were counted up and the following table obtained: —

(In this table C = cirrus; K = cumulus; S = stratus; N = nimbus; A = alto; f = fracto.)

PRECEDING RAIN.

Cloud Form,	C	C S	A S	C K	A K	S K	f N	No. Storms.
No. times observed,	106	108	100	53	57	42	17	135

BETWEEN RAINS.

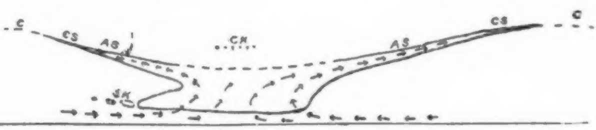
Cloud Form,	C	C S	A S	C K	A K	S K	f N	No. Storms.
No. times observed,	4	3	12	15	11	16	17	37

FOLLOWING RAIN.

Cloud Form,	C	C S	A S	C K	A K	S K	f N	No. Storms.
No. times observed,	47	40	26	23	30	66	19	108

It is seen that the most frequent clouds preceding rain, as previously determined, are cirrus, cirro-stratus, and alto-stratus; the most frequent clouds between intervals of rain are cirro-cumulus above and strato-cumulus or fracto-nimbus below; and the most frequent clouds following rain are strato-cumulus below and cirrus or cirro-stratus above. This rule applies principally to general storms. Preceding thunder showers the most frequent upper clouds were cirro-cumulus or alto-cumulus.

The accompanying diagram is intended to illustrate the most frequent succession of clouds in rain storms, as indicated by the observations. The symbols are the same as in the last table.



It will be seen from the diagram that the cloud sheet accompanying general rains is conceived to be dish shaped. For this there are two reasons: First. In typical rain storms the clouds in front clearly form a single cloud sheet. This sheet, beginning with the cirrus, grows gradually lower and assumes the different forms which direct measurements at this observatory show to be successively lower from the cirrus at an average altitude of 8,900 meters to the nimbus at an average altitude of about 700 meters. Second. Balloon observations indicate that the top of the nimbus is much below that of the cirrus since æronauts frequently pass through and above the nimbus at an altitude of only one or two thousand meters. Tissandier gives a number of such cases ("*Observations Météorologiques en Ballon*"; "*Histoire de mes Ascensions*," page 131).

Rain storms with two or more strata are more frequent in summer than in winter, and are probably connected with feeble cyclones and weak ascending currents which allow the heavier portions of the cloud to descend and form a second stratum composed of rounded dissolving cloud forms. When the drift of the upper clouds is very rapid the upper cloud sheet in the rear tends to disappear so there is only one sheet of high clouds in front and low clouds in the rear.

The number of hours the first clouds appeared before the

beginning of rain and the last clouds disappeared after the ending of rain, were tabulated for all the available storms during 1887 and 1888. In cases where the sky did not entirely clear between succeeding storms, only the first storm was considered. In many cases also the first clouds appeared or the clouds disappeared during the night when no observations were taken. Hence, the number of cases is limited and is not equal for the two conditions. The following is a summary of the results obtained: —

NUMBER OF TIMES FIRST CLOUD PRECEDED AND LAST CLOUD FOLLOWED RAIN.

Hours......	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49
First Cloud..	0	3	11	**14**	12	10	4	5	3	2
Last Cloud...	4	**18**	13	15	9	2	2	6	3	2

It will be seen that the first cloud which appeared after a cloudless interval preceded the rain most frequently between fifteen and twenty hours and disappeared most frequently between five and nine hours after the rain. The first cloud was usually cirrus but sometimes a lower cloud form.

The following table gives a summary of the number of times, during successive five hours, rain followed the first appearance of each cloud form: —

Hours......	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-69
Cirrus.......	1	4	6	10	11	**12**	6	4	7+	5	2	4+	4
Cirro-Cum..	3	8	7	5	**10**	9	5	6+	2	2	4+	3	2
Cirro-Str....	1	14	**16**	15	10	5	8+	6	4	6+	5	4	4
Alto-Cum...	6	**15**	9	3	4	6+	5	0	2+	2	0	-	-
Alto-Str.....	14	**31**	13	6	7+	3	2	3+	1	2	2	0	6

This table indicates that cirrus first appears most frequently about twenty-six hours before the rain, cirro-cumulus about twenty-two hours, cirro-stratus about thirteen hours, alto-cumulus about eight hours, and alto-stratus about six hours. Mr. Arthur Sweetland in inspecting this table pointed out that there were secondary maxima following the chief maxima at intervals of fifteen hours. These are marked by crosses and seem too regular to be considered accidental.

To determine in what proportion of the cases the first appearance of each cloud form was followed by rain within twenty-four

hours at the station of observation the following table was constructed : —

	Cirrus.	Cirro-Cum.	Cirro-Str.	Alto-Cum.	Alto-Str.
Number of cases	159	137	160	84	142
Number times rain in 24 hours	53	50	71	38	97
Rain in 24 hours in per cent	33	36	44	45	68

The number of cases in this table is greater than in the preceding because in many cases where the clouds first appeared in the night, it was possible to determine whether rain fell within twenty-four hours, although the exact number of hours they preceded the rain was not known. It will be seen from the table that the frequency with which each cloud form is followed by rain increased from the cirrus with 33 per cent down to the alto-stratus with nearly 70 per cent, and that the stratiform clouds are more frequently followed by rain than the other cloud forms at the same level. The average frequency with which cirrus is followed by rain during the second twenty-four hours following its first appearance is 31 per cent, making the total probability of rain, for forty-eight hours after the first appearance of the cirrus, 64 per cent.

In the preceding table a sprinkle too small to measure, or, as it is generally called, a trace of rain, was considered as rainfall. The number of days on which a trace or more of rain fell during the two years was 316, making the average daily probability of rain 43 per cent. If any given hour, as for example 8 A. M., be taken, and all these cases eliminated in which rain is already falling, the average probability of rain for the succeeding twenty-four hours is 36 per cent. This latter seems a better standard of comparison with the percentage of rain following each cloud. Therefore, with the first appearance of cirrus and cirro-cumulus, the probability of rain for the next twenty-four hours is less than normal, but is greater than normal for cirro-stratus and alto-cumulus, and nearly twice as great for alto-stratus. A comparison with forecasts made from weather maps is difficult, since the percentage of success varies somewhat with individual skill. A verification of forecasts, made by a skilled forecaster for six months, indicates that about 65 per cent of the forecasts of rain

are followed by a trace or more of rain at Blue Hill during the succeeding twenty-four hours. If, however, it is considered that no forecasts were made when rain was already falling at the time of the forecasts, the percentage of success is reduced to 54. If the cases were also omitted where rain began before the forecasts reached the public, the percentage would be still further reduced.

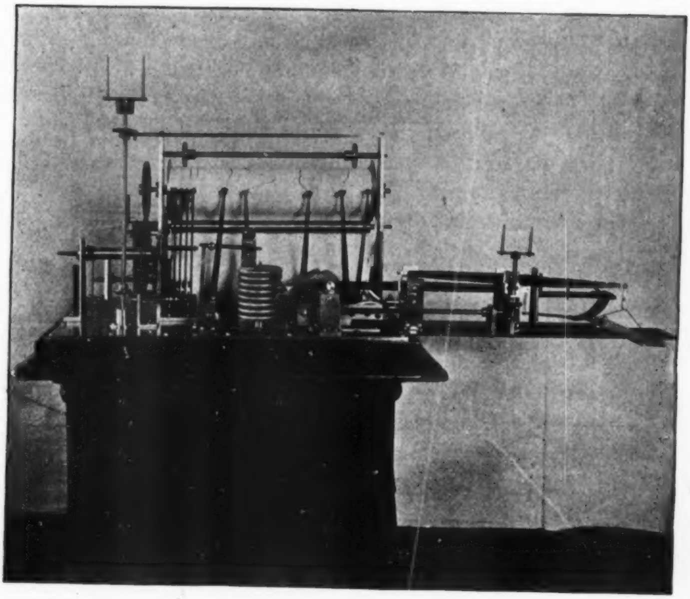
From the foregoing facts it appears evident that cloud forms cannot, in general, be used in predicting rain for an interval exceeding twenty-four hours, but for a few hours in advance the existence of certain cloud-forms frequently furnish the individual observer more reliable indications of the coming rain than does the weather map. If the detailed cloud forms, the pressure, wind, cloud movements, humidity, etc., were considered, the forecasting value of the clouds would no doubt be considerably increased.

THE METEOROGRAPH FOR THE HARVARD OBSERVATORY ON EL MISTI, PERU.*

S. P. FERGUSSON.

ACCOUNTS of the establishment of meteorological stations on Mont Blanc, by Messrs. Vallot and Janssen, and on Mt. Chachani and El Misti in Peru, by Messrs. Bailey and Pickering, have already been published in this JOURNAL. The heights of these mountains above sea level are, Mont Blanc, 15,780 feet; the Chachani station, 16,600 feet, and El Misti, 19,300 feet. It has been found impossible to maintain observers at these elevated stations because of the severity of the weather conditions. Mont Blanc can only be ascended under favorable circumstances during the summer months, and in Peru, the rainy season of three or four months each year prevents the ascent of El Misti and Chachani during its continuance. Observations have not been continuous at any of these stations since their establishment, but have been made during occasional visits or obtained from a few self-recording instruments which

* Read before the New England Meteorological Society, at Boston, on May 6, 1895.



are visited at intervals of ten days or a week for the purpose of changing the record sheets. The last method has been found the more satisfactory of the two, and the results obtained so far are of considerable value, the records of pressure, temperature, humidity, and, occasionally, wind velocity, being made by the well-known instruments of Richard Brothers.

Since these recording instruments work for a period of two weeks or less, observations and records at the stations during the rainy and winter seasons have been impossible, and recording apparatus capable of operating for several months without attention has been greatly needed, in order to obtain continuous records. A meteorograph, recording the five elements, wind direction and velocity, pressure, temperature, and humidity was constructed last year by Richard Brothers for Mr. Janssen's observatory on Mont Blanc. Each record is made upon a separate roll of paper, the five rolls being operated by the same clock which will run eight months without winding. The recording mechanisms are essentially the same as in the ordinary Richard apparatus, except that special pens for holding a large supply of ink are used. This instrument has worked satisfactorily in the laboratory of the makers at Paris, but has not yet been taken to the summit.

In November of last year, Prof. Pickering of Harvard Observatory employed the writer to experiment with different recording apparatus with the object of designing an instrument for the station on El Misti. The requirements were that the weight of the apparatus should not exceed 150 lbs. (that being the limit of weight carried by the mules used to convey supplies up the mountain), and that the parts should be so arranged as to require very little time for installation or adjustment when at the summit.

The general appearance, with the outer casing removed, of the instrument designed, is shown in the figure. The external parts of anemometer and anemoscope are not shown.

The clock is an eight-day Howard movement, altered by the addition of a large, slow-moving, winding arbor, so that a weight of 60 lbs. will run it for four months without re-winding, the weight descending three feet during the time. The large gear wheel on the winding arbor turns a smaller wheel on the shaft of the record drum which works horizontally between the two

main upright supports. The record drum revolves once during three days, giving to the paper a speed of $\frac{1}{8}$ inch an hour or 3 inches a day. The paper used for the records is rolled upon a removable reel under the record drum, and is held on the drum by a small roller underneath it, and a spindle carrying two milled heads resting on it at the top. This arrangement is necessary to prevent the paper from slipping. As the paper is used and passed over the record drum it is automatically rewound upon another reel operated by sufficient weight to keep the paper taut and insure uniform winding. One year's supply of paper may be placed upon the rolls at one time.

The wind direction is recorded by four pens operated by cams, so arranged that a record of eight possible directions is obtained. The cams are on a horizontal spindle connected by bevel gearing directly with the anemoscope shaft. The wind vane used rests upon a ball-bearing at the top of its support, and the intermediate shafting is adjustable for changes in level. A sliding joint nearing the recording mechanism is self-adjusting to any possible settling of the building or instrument.

Atmospheric pressure is recorded by the mechanism of a Richard aneroid barograph, one inch of variation in pressure causing a movement of two inches of the recording pen.

Wind velocity is recorded by a Weather Bureau anemometer, the mechanism being altered to admit of direct connection with the recording pen. The outside part is screwed to the top of its support, and the connecting shaft attached by a set screw. This shaft revolves once during each ten miles of wind, and operates by worm gearing, a heart cam turning once during 200 miles of wind and moving the recording pen across the paper and back again during a complete rotation. As in the anemoscope, the connecting shaft is adjustable. Gas pipe is used for the outside supports.

Temperature is recorded by a Richard thermograph bulb placed on a bar extending fourteen inches from the recording pen, with which it is connected by a light intermediate lever.

Relative humidity is recorded by a bundle of hairs placed at the end of the bar previously mentioned, the connection with the recording pen being similar to that of the thermograph.

The thermograph and hygrograph parts were placed at the distance mentioned to prevent, so far as possible, the drifting of

snow or rain into the recording mechanism, and to give the bulb and hair good ventilation.

The time is marked on the record paper by a pen making a dash at the end of each three days. The records are read by laying over them a transparent scale, graduated for each element and for the time divisions.

The record pens used in the anemoscope are glass pens such as are used in the Draper instruments. Those used for the other elements are nearly similar to those of Richard, except that they are made for vertical pen arms and much larger than the ordinary Richard pen.

The recording parts are protected by an iron case and are to be placed in a small wooden building with the thermograph and hygrograph mechanisms near a window which admits the outside air to these parts.

The principal difficulties to be met with in operating instruments of this kind are the stoppage of the clocks by severe weather and unforeseen causes, and the failure of the ink in the recording pens; and it is difficult to predict their future behavior from results obtained at lower levels and under favorable conditions. However, the clock used in the instrument described was run for several weeks in low and high temperatures and in extremes of moisture without stopping, and the pens have worked one month without much diminution in the quantity of ink originally placed in them.

Since it was completed this meteorograph has been in operation continuously for one month without a break in the records, and it is hoped that the same satisfactory performance will be continued on the summit of El Misti, where it is to be installed this summer.

Blue Hill Observatory, May 16, 1895.

ELECTRICAL PHENOMENA IN A DUST STORM.*

F. P. GULLIVER.

LAST fall, while doing geological field work for the United States Geological Survey in Colorado, the writer encountered a dust storm on the plains, with which were connected electric phenomena of some interest. On Oct. 27, 1894, the work of the day lay some 30 miles southeast of Pueblo and 10 miles south of the Arkansas River, in latitude 38° N. and longitude 104° 12′ W. The day had been more oppressive than is usual in Colorado, and there were several thunder-showers during the late forenoon and afternoon. Pikes Peak and the Spanish Peaks were covered with cloud during a good part of the day, and the following morning, Oct. 28, they showed a fresh cap of snow. They had been partly covered with snow since early in September.

About 2 P. M. on the 27th there was a heavy thunderstorm which moved east down the Arkansas River. At about the same time there was another thunderstorm south of Pueblo along the east base of the Greenhorn Mountains. The latter storm was, therefore, some 30 or 40 miles west of the point to which your attention is now to be directed, and the former 10 miles to the north. The south edge of the Arkansas storm reached the observer, enough rain falling to moisten the surface of the ground, though the horse's hoofs stirred considerable dust. After the drops ceased, the wind from the southwest sprung up and brought much dust with it, so that by 3 P. M. the sun was entirely obscured and the air densely laden with the fine soil from the Cretaceous sediments. The darkening was very noticeable, and the dust was so thick that it was impossible to see to trace geological outcrops. When the dust storm was at its height one could not distinguish objects more than 200 feet away. At about 3 P. M., while the dust storm was nearly at its maximum, the writer came to a wire fence in which there was a gate, and thus he did not have to draw the staples from sev-

*Read before the New England Meteorological Society at Boston, Mass., May 6, 1895.

eral posts and press down the barbed wires to allow his saddle animal to step over in the usual method of passing a fence out on the plains.

In order to make the conditions clear under which the electricity was observed, it will be necessary to give a description of the construction of the fence and gate. In Fig. 1, *c* and *d* are

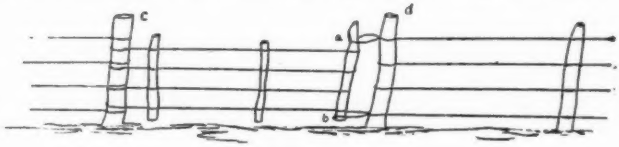


FIG. 1.

the two gate posts and between them runs the trail. To go through, one presses the bar *a b* towards the post *d* and then lifts the wire loop off from the bar at *a*, whereupon the bar slips out of the lower loop at *b* and the gate with the wires thus loosened may be laid back out of the road. Each of the four barbed wires of the fence is separate from the others. In many cases the loops at top and bottom form a connection across the gate so that a current of electricity may pass along either the top or bottom wires, but never along either of the two middle ones. In the gate, however, with which we are at present concerned, the top loop was fastened into a notch so far above the upper gate wire that there was no possibility for a current to pass across.

In opening the gate the writer received a decided shock of electricity which was a complete surprise to him. The following extract from a letter written the following day will give the impressions of the time better than any rephrasing at this later date. "When I started to open the gate a sharp snap made me quickly let go my hold of the loop. I was interested to try again, and let go as suddenly as before. In the dim light beneath the dust cloud I could see a pretty good-sized spark snap from the wire to my hand. I finally took my geological hammer and lifted off the loop. I wanted to find out if the current had any connection with the gate, so while the gate was open I again touched the loop. The result was the same. After leading my mare through I tried to put the loop on the end-stick of the gate with my hammer. The wires are stretched so taut

that it required considerable pull to bring fence post and gate together. Not succeeding in this, I took my pocket-handkerchief and putting it in my hand for a non-conductor attempted to pull the loop over the stick in the usual way. The current was too strong and my handkerchief too good a conductor. I finally succeeded in shutting the gate, using my hammer." (Oct. 28, 1894.)

The electrification of the wires upon the gate was very slight if there was any at all. I handled these considerably and if they had been much charged I should have noticed the fact. In comparison with the top wire of the fence it is safe to say that the gate wires were not electrified. I did not test the electrification of the three lower wires of the fence and cannot say whether they were charged or not. The lower loop, however, I did lift with my boot to insert the lower end of the gate bar and felt no shock. The wire forming the upper loop was double and considerably twisted, and at the moment I attributed the electrification to the effect of the friction of the dust-laden air upon the twisted wire. Further consideration leads to the conclusion that the twisting had nothing to do with the electrification.

The origin of atmospheric electricity is to-day an unsolved problem, and the above-mentioned incident is presented with the hope that some future observer may profit by the writer's experience and gain more as to the effect of dust-laden wind upon the amount of electricity in the air. The earth has a certain amount of electricity which is irregularly distributed in the air and which often becomes locally concentrated. The extremely local character of the phenomena is shown by the studies of Mr. Alexander McAdie and others in Dr. Mendenhall's report (page 173). These studies show that a negative potential with reference to the earth generally accompanies precipitation and frequently precedes it, a fact pointed out by Lord Kelvin nearly forty years ago. It did not appear to be wise to continue investigation of the subject with reference to weather prediction. Negative potentials frequently occur, though for the greater portion of the time the air has a slight positive charge as compared with the earth's potential. The friction of dry dust-laden air is doubtless a true cause of an increase in the amount of local electrification. The rubbing of one layer over

another is here called electrification by friction, though according to a recent theory it may perhaps more properly be of the nature of a chemical action.

Mr. Bidwell has shown (Q. J. Roy. Met. Soc., XIX., 1893, 162) that the evaporation of water from hot sand causes electrification of the atmosphere, though experiments by Prof. John Trowbridge, at Harvard, would indicate no electrification of the air from evaporation. I understand from him that he did not use hot sand. Prof. Davis has said that the source of atmospheric electricity has also been ascribed to the friction of water particles and dry snow-flakes in the upper part of agitated clouds. His comment upon this theory is, "this process seems too exceptional to serve as the cause of so general a result." (Elemen. Met., 1894, page 265.)

The lack of strong electrification upon the Colorado gate wires would imply that the dust storm, though doubtless a true cause of a portion of the charge, was not the only source of electricity, or at least that the top wire of the fence must obtain its current from a more extended region. Fig. 2 shows the relation of the top wire and its probable connection with the fences of the surrounding area. The wire loop on the gate post *d* is seen to be connected with a circuit running around a small pasture of from one to two square miles. The probability is that the circuit is complete, although I cannot say from observation that this is surely a fact. We have before seen that there is no connection across the gate at *x*. Other gates in the pasture fence may cause a similar break in the circuit. If the total electrification of the four or five miles of wire was due to the friction of the dust-laden air, each of the four shocks received might not have completely discharged such a storage reservoir, or the collecting surface was so large that after each discharge there was a gathering of electricity sufficient for the succeeding shock.

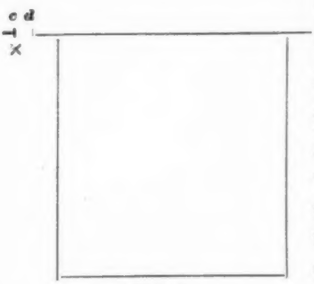


Fig. 2.

Prof. Trowbridge has suggested that this circuit may have been inductively charged by one of the thunderstorms not so

very far distant, in the same way that telephone circuits become charged. This would explain the difference in charge between the top fence wire and the gate wires. The distinction in the effect produced upon a man between an electro-static shock and an electro-magnetic shock was not in mind at the time, and the writer therefore is not now able to state whether the electrification was produced entirely by the dust storm or whether the thunderstorm may have been effectual. A slight charge was felt in two other cases during dust storms when passing through a wire fence, but no other severe shock was experienced.

CURRENT NOTES.

The Meteorological and Magnetical Observatory at Zi-ka-wei. — The following circular letter has been sent out by Rev. Father Chevalier, S. J., Director of the Zi-ka-wei Observatory: —

"The Zi-ka-wei Observatory, founded in 1873 by the French Roman Catholic Mission of Kiang-nan, has been provided by the same with all the instruments necessary for the study of Meteorology and Terrestrial Magnetism, and from that time it has not ceased to pursue actively the study of those two branches of science. The work of the Observatory comprises three parts: —

"1. The first part is a public service accepted out of good will and, it may be said, gratuitously, in behalf of the port of Shanghai. This manifold service includes the service of the time-ball by which the exact time is given to the port of Shanghai by the fall of a meridian ball; a daily bulletin, posted up at Shanghai, contains information on the weather at Shanghai and along the coast of China; the typhoon and storm warnings by means of signals hoisted up at a semaphore. 2. The second part of our work is composed of hourly meteorological and magnetical observations published in monthly bulletins, which make at the end of each year a volume in 4to, of over 200 pages. 3. The third part comprises special studies on meteorological or magnetical subjects; the whole of which comprises already 26 memoirs.

"But up to the present the study of astronomy has been altogether left aside. When the service of the time-ball was inaugurated at Shanghai, twelve years ago, by the care of the Municipal Council of the French Settlement, the Observatory received, at the expenses of that Council, a little transit instrument good for the determination of the time but altogether inadequate to astronomical observations, properly so called. This absence of instruments fit for astronomical studies we have seen it regretted by many learned men. To quote but one only, Mr. A. Tissandier, relating in *La Nature, No.* 944, his visit to the Zi-ka-wei Observatory, expressed his regret of seeing us neglecting astronomy. Our too limited staff had prevented us till now, just as much as the lack of pecuniary means, to think seriously about giving to our Observatory a so eagerly longed for development. At present we would be in a better condition even to undertake a series of studies in that so interesting branch of science. But it is quite impossible that the Catholic Mission, which has made so many expenses to found the Observatory and maintain it in its present state, make to itself the expenses for such an establishment. It is even impossible that it can suffice for the cost of the instrument which we wish to set up in the first place, *i. e.*, an equatorial telescope of becoming size. We must then necessarily have recourse to the generosity of those interested in the advance of science, and particularly in the studies made at Zi-ka-wei. The city of Shanghai profit

ing above all by our work, it was then quite natural that we first of all address ourselves to it. And that we have done in demanding from the two settlements (English and French) to be so kind as to contribute each for a sum of £400 to the setting up of an equatorial telescope at the Zi-ka-wei Observatory. That proposal brought before the meeting of the ratepayers of the English settlement on the 12th March by Mr. G. J. Morrison and seconded by Mr. J. Henningsen has been received with the marks of the greatest sympathy and voted unanimously.

"The following is the report of the meeting as has been inserted in the newspapers of Shanghai: —

"Mr. Morrison. — I beg to propose Resolution XI.: —

"*Resolution XI.* — That the Council be and are authorized to grant a sum not exceeding £400 towards the cost of erecting an Equatorial Telescope at the Zi-ka-wei Observatory.

"Père Chevalier and his colleagues have done a very great deal for these Settlements. [*Hear, hear.*] By establishing and working a time-ball and observatory, they have conferred a boon upon every one directly and indirectly associated with shipping, and that is the entire community. The advantage to steamers visiting this port of being able to get the exact time to set their chronometers is one that cannot be over-estimated, and in addition to that, the weather reports from the various stations are collected at Zi-ka-wei and the present state of the weather at various places, and forecasts as to the future state of the weather are indicated by signals, and published in a way that makes the information readily accessible to all those interested in the subject. Now, towards the expense of all this, I believe this Settlement has never subscribed anything, and it is only fair that we should do something to show our appreciation of the services which have been rendered by Père Chevalier. [*Hear, hear.*] I might probably stop here because I feel I have the support of the meeting, but in case anyone should ask what is the use of an equatorial telescope I think I will say one or two words. [*After a few words on that subject Mr. Morrison concluded his speech by the following words:*] So it will be in this case; and I am sure if we assist in placing in the hands of Père Chevalier this valuable instrument, although we do not know what results will be obtained by it, not only the community here but the world at large will be much the richer. I have great pleasure in proposing the resolution authorizing the grant.

"Mr. J. Henningsen. — I have much pleasure in seconding that proposition.

"Mr. Scott (Chairman of the Council). — I should like to say a word or two, for I quite agree that the Zi-ka-wei Observatory has done a great deal for Shanghai. It has given us the exact time, which is an absolute necessity for proper navigation, and therefore the safety of vessels which leave this port, and all of us, whether owners, shipping-masters, or insurance companies, are indebted to the meteorological signals which are of so much importance, and which have been provided by the Observatory for years. In most parts of the world the obtaining of these things costs money. In Hongkong, the Government recognizes their importance by having a paid astronomer. We, however, receive the service free of cost from the Zi-ka-wei

Observatory. I think, therefore, after the gratuitous receipt for so many years of this valuable information, and information which must have cost something to get, that it is some recognition on our part and it would be a graceful act if we marked our appreciation of these benefits by giving the donation now asked for. [*Applause.*]

"The amendment was put to the meeting and carried unanimously.

"A similar reception of my demand has been made at the meeting of the French Municipal Council on the 1st of April, and the Council granted likewise a sum of £400 to the Observatory for the same end. Besides, the shipping companies established at Shanghai have promised to subscribe for the same purpose a sum, the amount of which their agents have not been able to fix immediately, but the sum total may, perhaps, be equivalent to £400. But this sum of £1,200 will be very little for an equatorial telescope of convenient size, for instance, of an aperture of 20 inches; very little especially for a complete astronomical observatory.

"I have made up my mind to address myself to all those to whom the Lord has distributed, together with fortune, the love of sciences and the desire of utilizing for its advance the fortune they possess. It is to them to whom I make application, begging them to be so kind as to contribute, according to the pecuniary means they may dispose of, to that development of the Zi-ka-wei Observatory. I am aware that to solicit thus of the public a subscription in favor of a private institution, it would be necessary to be able to present, simultaneously, titles to the benevolence and guarantees that the solicited money will be usefully employed for the proposed end. But the Zi-ka-wei Observatory can present, I believe, both. Its title to the benevolence is its past and its work of which I have spoken about above,—titles which, as it has been seen, are far from being denied by the community of Shanghai. The said work constitutes also, I presume, the best guarantee that the asked for money will be usefully employed. My claim, being founded on these considerations, I dare hope that my request will be received kindly and that numerous benefactors will be willing to help us to succeed in this useful undertaking."

*Local Winds and Clouds at New Lebanon, N. Y.** — Two curious weather phenomena are reported from New Lebanon Valley (Columbia County, N. Y.), through which runs the boundary between the Empire State and Massachusetts. On the eastern side the Taconic range stretches in a direction almost due north and south, and rises from 2,000 to 2,400 feet above sea level. On the western side are Ives Hill (a few hundred feet lower, but more abrupt in its ascent) and an extension of West Hill, between which and Ives Hill there is a broad cut reaching off to the westward. To the eastward of the Taconic lies Pittsfield, on a plane nearly a thousand feet higher than the bottom of New Lebanon Valley. The western slope of the ridge, therefore, is about a mile broader than the eastern, so that that once celebrated resort, New Lebanon Springs, is near the bottom, and the Lebanon Shaker Village is almost half way up the Taconic.

When conditions favorable to the development of an easterly storm in

* From the New York *Weekly Tribune*, Feb. 13, 1895.

this vicinity prevail, says our informant, A. P. Hitchcock, the first appearance of cloudiness is often a low bank over the eastern ridge. This gradually extends toward the zenith. Though it apparently remains stationary, masses of visible vapor are torn off from its upper edge by the winds and go driving westward. Hardly have they become detached before they disappear, only to reappear as they approach the crest of the western wall of the valley. In time a second cloudbank is formed here, also, with a broad lane of clear blue sky between. Then this open area grows narrower, and turns whitish, until the whole heaven is a mass of clouds hurrying westward. Finally precipitation sets in. Frequently it takes a whole day for the process to complete itself, and then the rain may last two days more. Sometimes the series of incidents just described is reversed at the close of the storm, but with the wind still coming from the east. On other occasions, the sky clears under the influence of a northwest wind, which sweeps every patch of vapor away as with a new broom.

This cloud formation is a familiar occurrence in other places, and is due to the condensation of previously invisible vapor, resulting from elevation to a region where the atmosphere is more rare than lower down. Speaking of this subject, Prof. W. M. Davis, of Cambridge, in his "Elementary Meteorology," says: "Any process by which the air is raised to levels of less pressure will serve, if carried far enough. Thus, when the damp trade winds blow against a mountain slope and rise to pass over it, they soon become cloudy. If the winds are strong and the mountains high the clouds may grow so large as to give forth rain." Of course, in Columbia County, N. Y., the east winds are not trades, and the cloudiness is the result of two causes combined, the approach of a cyclonic wind system and the uplift given by the Taconic range and the hills west of it to the damp air currents thus drawn in from the New England coast. In other parts of the world, where no organized storm is approaching, clouds often form above a peak or ridge and float for hours at a time, day after day, like a banner from a castle. Owing to admixture with drier air, or, possibly, to a slight dipping of the moist stratum to a level where the air is denser, the vapor is reabsorbed and the cloud dissolves at its further end. Sometimes there is a second bank of cloud called the "Helm Bar," parallel with and to the leeward of the first, due to a second undulation in the current, such waves being caused, however, by the first barrier rather than by an additional ridge such as is found on the western side of New Lebanon Valley.

But the phase of an easterly storm in the latter locality that is most difficult to explain is the inequality of wind force observed at various points during the prevalence of weather of that type. Mr. Hitchcock (whose house is southwest of the Shakers, and southeast of Ives Hill) says:—

"Invariably in such storms the wind blows vigorously down where I live, very lightly, if at all, at New Lebanon Centre, and becomes a gale at the Springs and the Shakers. The last two points are close under the lee of the Taconics, the Shaker settlement being built partly up the mountain side. One day, recently, I was at the Centre while an easterly storm was at its height. A light snow was falling as quietly as down and resting on the fine twigs of the trees without being jarred off by even a zephyr. When I

got half way home the wind was strong. At home it was blowing sharply. I had to go directly up to the Shaker Village, and there the gale was tremendous, swirling the snow into drifts and breaking off limbs from big trees. At the Springs it is quite as strong. On my way back I met a neighbor just returning from the Centre, who told me that the air there was as quiet as in the morning. It is strange that under the lee of a high and close ridge the east wind should be stronger than three miles west of that lee, in a funnel-shaped valley which seems to offer a particularly fine channel for a gale to gather sweep and force in. The wind really appears, and is believed here to originate, on the western slope of the Taconic. People start from the Centre, where it is practically calm, climb the ridge in the face of a constantly increasing gale, find the wind subside at the summit, and then can make their way to Pittsfield, across a practically level country, six miles from the mountain, without feeling any wind to speak of. Coming back, they ride in calm to the top of the mountain; there they are again beset by a howling gale, which follows them to the western foot and a mile or two beyond, and then dies away again. Now, this latter fact I cannot vouch for personally from my own observation. I am told it by those who are accustomed to drive over the mountain. The region to the eastward of the Taconic is a plain about fifteen miles across, with no steep and continuous ridge beyond; nothing but a broken country, stretching away toward the Connecticut, still further distant."

Mr. Hitchcock, who has repeatedly noticed the steady tumultuous roar of the wind up the mountain east of him during an easterly storm, compares it to the sound of the distant sea in a heavy gale. He also quotes a passage from a book of President Dwight's describing a horseback journey from Hudson eastward to Sheffield, Conn., in 1804, across this very Taconic ridge, but at a point about twenty-five miles south of New Lebanon. On that occasion the writer started in a light breeze that changed, at the foot of the lower western acclivities, to an "uncomfortable and furious blast, which continued during the whole time of our ascent, the distance being about a mile and a half or two miles. After we had gone over this distance the violence of the blast ceased, and was perceived by us no more, either on the sides or the ridge. Still the noise" — previously referred to as "loud and majestic," which had been heard while the rider was four or five miles away from the mountain — "was undiminished, and seemed to fill the heavens with a stormy, tumultuous grandeur. The wind was evidently confined to a very narrow region."

The Progress of Meteorology. — Under the title of "The Progress of Meteorology," Dr. Frank Waldo, of Princeton, N. J., has an article in the *North American Review* for May, 1895 (pages 580–588). The writer takes up briefly some historic points of interest in connection with meteorological observations, records, and instruments, and then notes certain noteworthy steps in advance made in recent years. "In looking backwards," says Dr. Waldo, "over the extensive literature which has been produced concerning meteorology, I find two books which, more than others, furnish us with satisfactory reviews of the science up to the dates of their publication.

These books are Kaemtz's "*Lehrbuch der Meteorologie,*" 1836, and Schmidt's "*Lehrbuch der Meteorologie,*" 1860. We have no such works as these in either the English or French language. The progressive strides made in the subject since 1860, and especially within the past twenty years, have now rendered impossible any such recapitulative work in a single volume, or, indeed, by any individual author in a number of volumes. There are now, probably, a score of modern treatises on meteorology, by as many different authors, in which the main results of our progress have been brought before the reading or student public; but in nearly all of these cases selected topics have been treated to the exclusion of others of equal importance, but which could not be crowded into the pages of individual works. Thus we find even popular works specialized."

Regarding weather maps Dr. Waldo says: "Our weather maps have remained practically unchanged in form for years, and I venture to suggest that if the Weather Bureau would give us, for only one year, maps of the weather conditions two or three times a day, as shown by records from all of the State meteorological stations, as well as those from the present general government stations, we should have the means of studying the process of storm development with a much greater probability of adding to our present knowledge than is likely to occur without some such change in the plan now in use. In order to have storms so minutely portrayed as this would allow, we who are students would gladly wait for the maps a month or two as might be necessary."

In conclusion, Dr. Waldo speaks of the modern development of theoretical meteorology, and refers to the share that Ferrel and others have had in this work.

Ocean Spray Carried by Winds. — The spray blown by violent winds from the ocean waves is often carried for some distance inland in storms, and the salt, left after the evaporation of the spray, may be found on vegetation, the windows of houses, etc. In Symons's "Monthly Meteorological Magazine" for January and for May, 1895, there are some notes on occurrences of this kind. Mr. Albert Wilson, of Garstang, Lancashire, reports that on Dec. 23, 1894, the day after a violent gale, all objects, such as twigs and branches of trees, plants, grass, etc., tasted very strongly of salt. An analysis of water collected during a fine drizzle from the drops on the twigs and branches of apple-trees showed that the salt was almost precisely identical with sea salt.

During this same gale salt was detected at stations from twenty-four to sixty-five miles from the coast, and two observers at Birmingham report that objects near that city were encrusted with salt, the distance of Birmingham from Bristol Channel being about fifty-five miles, and from Cardigan Bay nearly one hundred miles.

A communication to the "Gentleman's Magazine," written Oct. 23, 1756, gives an interesting account of the occurrence of salt incrustations on Oct. 6 of that year. On that day a violent gale blew, lasting four hours. After it "the change in the herbage was very surprising, its leaves *withered, shrivelled up, and turned black.* The leaves upon the trees, especially on

the weather side, fared in the same manner. The *evergreens* alone seem to have escaped, and the grass recovered in a day or two. I agreed, at first," says the writer, "with the general opinion, that this mischief was the effect of *lightning*; but when I recollected that, in some places, very little had been taken notice of, in others none at all, and that the effect was *general*, I began to think of accounting for it from some other cause. I immediately examined the dew or rain which had been left on the grass, windows, etc., in hopes of being able, by *its taste*, to form some better judgment of the particles with which the air had been impregnated, and I found it as salt as any sea water I had ever tasted. The several vegetables were also all saltish, more or less, and continued so for five or six days, the saline particles not being then washed off; and when the moisture was exhaled from the windows, the saline crystal *sparkled* on the outside, when the sun shined, and appeared very *brilliant*. The *salt water*, I conceive, has done the principal damage, for I find upon experiment, that common salt dissolved in fresh water affected some fresh vegetables, when sprinkled upon them, in the very *same manner*, except that it did not turn them quite so black, but particles of sulphurous, or other quality, may have been mixed with it."

Lunar Tides in the Atmosphere. — At the regular meeting of the Meteorological Society of France, April 2, 1895, M. A. Poincaré communicated the results of his recent work on the subject of the influence of the moon on the motions of the atmosphere between two successive returns to two similar phases of the moon, or about 27⅓ days. He expresses himself thus: —

"I have again taken up my studies (made in 1886–89, by means of the charts of the 'Bulletin of International Simultaneous Observation,' published by the Weather Bureau of the Army Signal Office), on the relations between the motions of the atmosphere and the movements of the moon. The discussion of the annual curves of mean pressures along several terrestrial parallels had shown me in a distinct and positive manner the effects of the several revolutions of our satellite. The mean barometric condition along an entire terrestrial zone shows changes that depend, apart from the solar influence, principally upon the tropical revolution of the moon, which satellite was thus seen to have an influence upon the mean atmospheric condition of the atmosphere. The other revolutions of the moon exert nearly all their influences on the distribution of pressure between the meridians, on the changes of the places of rupture of the belt of calms, and on the local atmospheric conditions.

"I had sought to demonstrate the laws of the oscillations in barometric pressure for each parallel of latitude, as also those of the boundary of the region occupied by the trade-winds, in so far as these correspond to the changes in the declination of the moon.

"In order to render these effects more evident, I have now studied the displacements of the average latitude of the lines of barometric maxima in the temperate zone, lines on which the mean atmospheric conditions of the zone directly depend.

"Until I am able to study the extreme years of a whole period of the revolution of the node (or 19 years), I have taken the two annual intervals most distant from each other, furnished by the existing charts, or that from June 15, 1878, to June 19, 1879, where the mean amplitude of the oscillation of the moon in declination is 53.4°; and that from June 20, 1883, to June 22, 1884, where it is 38.4.°

"I have calculated the mean latitudes of the lines of barometric maxima as traced on the south side of the depressions of the temperate zone. • The differences between these latitudes for a northern and a southern lunation were, during the year 1883–84, less than two thirds of those of 1878–79. This diminution of the range of oscillation is due, almost exclusively, to the increase in the latitude of the line corresponding to the southern lunations; this confirms a remark previously made with reference to the oscillation of the boundary of the trade-wind region. The mean atmospheric conditions are powerfully and periodically influenced by the moon during each *tropical revolution* and during each *revolution of its node.*"

The Maximum and Minimum Temperatures in Norway. — In the May number of the "Scottish Geographical Magazine" is a short paper on the maximum and minimum temperatures of the air in Norway, contributed by Prof. Mohn, of Christiania. Prof. Mohn gave a list of the highest and lowest temperatures for every month for 48 stations, in the "Norwegian Almanac for 1891," which list he has now revised, on the basis of more recent observations. The winter of 1894–95 brought remarkably low temperatures, as did the winter preceding, and the summer of 1894 was exceptionally warm.

The absolutely lowest registered temperature in Norway is —60.5°, at Karasjok, in Finmark. The highest minimum was recorded at the lighthouses of Ona and Skomvær, the latter, the outermost island of the Lofoten group, where the Atlantic Ocean directly impinges on the coast with its northward-running current. The Naze (Lindesnes) and the North Cape, the most southern and the most northern points of the country, had the same minimum temperature, —4° F. The most severe cold is experienced along the axis of the peninsula of Scandinavia, particularly between the Gulf of Bothnia and the Arctic.

Temperatures of 86° F. and over have been observed at about twenty stations, one station, Nyborg, recording 95° F. The lowest maximum temperatures occur at these stations on the west coast. The maximum absolute range is 148.5° F. at Karasjok, and the minimum, 51° F. at Skomvær.

The Summer Type of Weather on the Northern Pacific Coast. — The 5 A. M. (Pacific time) weather map, of April 20, 1895, issued by the Portland, Ore., office of the United States Weather Bureau, is an interesting one, as it shows the beginning of the weather conditions characteristic of the summer season. From the synopsis prepared by Mr. B. S. Pague, Local Forecast Official at Portland, we quote the following: "The summer type of weather conditions prevails this morning. An area of high barometric pressure which, on Tuesday (April 16) evening, appeared off the

northern California coast, and which gradually moved northerly over western Oregon and western Washington, is central this morning over western British Columbia. This movement of the atmosphere is the first that has occurred since the fore part of last October, and it marks the commencement of summer from a meteorological point of view. While there may, and most likely will be, a recurrence of the atmospheric movements peculiar to the winter season, yet, after the first pure summer movement, there is little possibility of any long continued period of rainy weather. The gradual northward movement of the areas of high pressure along the coast, culminating in the perfect type of summer conditions, such as prevail this morning, indicates that the storm areas are receding northward and across the mountains far to the north, thus indicating that a dry season is probable from now on. The rain that occurs from now until autumn will most likely be in the form of scattered showers, rather than in the form of general rain."

Hurricane Warnings from Yucatan.—The "Louisiana Weather Journal and Agriculturist," of May 10, 1895, contains a note regarding the establishment of a new hurricane station in Yucatan. An arrangement has been made between the chief of the Weather Bureau and Mr. Felix Gomez, meteorological observer at Merida, Yucatan, whereby observations will be cabled from Merida to New Orleans during the hurricane season, or when, in the opinion of the observer at Merida, the conditions indicate severe storm development or movement. In connection with this arrangement Mr. R. E. Kerkham, Local Forecast Official at New Orleans, says in the "Weather Journal," "This is the first link in the chain of stations that will probably be established along the western and southern borders of the Gulf in the near future. . . . We hope ere long to chronicle the fact that the network of stations demanded has been established. A thorough co-operation on the part of the Mexican Meteorological Bureau with the United States Weather Bureau would be of great importance and benefit to both countries, and even a partial co-operation would be highly beneficial. To receive telegraphic advices from a point in Northern Mexico, and from Vera Cruz and Tampico, would go far towards perfecting the Gulf service of the Weather Bureau, while warnings emanating from Washington could be sent the Mexican Bureau of cold waves sweeping southward or of storms entering into the Gulf over the West Indies, in which islands we now have several observers."

CORRESPONDENCE.

THE CAUSE OF CYCLONES.

EDITOR OF THE AMERICAN METEOROLOGICAL JOURNAL:

I should be glad of a few lines to reply to Prof. Woeikof's remarks. Firstly, with regard to the temperature of mountain peaks: I do not think that this temperature must of necessity be higher than that of the free air, but I wished to protest against these temperatures being taken as a positive fact on which an objection to Ferrel's theory can be based, while great doubt is felt as to their value *; and I instanced a cause which in my judgment might make them too high.

With reference to the second point Prof. Woeikof has entirely misunderstood my meaning.

I thought that it was a well understood and elementary principle in meteorology that a low barometer was caused by the mere mechanical action of the air moving in a curved path round the centre of low pressure, just as a depression is caused in the centre of a cup of tea when the tea is stirred round. Long since Ferrel thus explained the low pressures at the poles, and their total absence within a few degrees of the equator, thus including the Malay peninsula where there is a copious rainfall; but where, owing to the absence of any directive force due to the earth's rotation, circular whirls never occur.

I have nowhere asserted that rainfall must cause a low barometer, but the kinetic energy exhibited by even a moderate cyclonic storm may amount to a thousand million million (1000,000,000,000,000) foot tons, and this enormous amount of energy must have some source. This energy most certainly may be produced by the latent heat of condensation, but it does not follow that the latent heat set free always takes the form of kinetic energy, other conditions being necessary, just as a mountain stream does not always turn a mill, although it may possess ample power to do so.

According to Blanford the cyclones of the Bay of Bengal are always inaugurated by a copious rainfall; but why in some cases rain should produce a cyclonic storm, and in some cases should not do so, is a question that cannot be fully answered in the present state of meteorological science, still it seems to be a fact that no storm is ever maintained for any length of time without rain.

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* See "Studies of the Upper Air," by A. Lawrence Rotch.

BIBLIOGRAPHICAL NOTES.

THE CLIMATE OF THE STATE OF NEW YORK.

E. T. TURNER. *The Climate of the State of New York.* Fifth Annual Report of the Meteorological Bureau and Weather Service of the State of New York, 1893. Under the State Department of Agriculture and in Co-operation with the U. S. Weather Bureau. 8vo. Albany, N. Y., 1894. pp. 345–448. Tables and Charts.

The State Weather Service of New York is one of the best in the country, and, under the able directorship of Prof. E. A. Fuertes, has been doing admirable work during the past five years of its existence. Its *Monthly Reviews* always contain carefully drawn temperature and precipitation charts, which are invaluable for the careful study of the climate of the State, and its *Annual Report* presents the full series of these monthly charts, as well as the mean annual charts. One is sometimes apt to wonder whether all the elaborate machinery of our State Weather Services, with their thousands of observers, is giving us as much information about our climatic conditions as it should, but all such doubts disappear when, from time to time, some notable contribution of a climatic nature comes to us from one State or another. Such a contribution is that of Mr. Turner, on the Climate of the State of New York, which is published in the Fifth Annual Report of the New York Weather Service.

From a note by Prof. Fuertes, at the beginning of the paper, we learn that this special report on the climate of the State was intended originally to form part of the investigations of the New York Meteorological Bureau, in connection with a more advanced scheme of researches still under contemplation, and now under way in some directions. At the request of the Chief of the Weather Bureau, however, Mr. Turner was placed in charge of the preparation of the Report, the Weather Bureau paying the expense attending the work and furnishing valuable data.

Mr. Turner's report is one of extreme value. We are prevented from making any extended review of it through lack of space, but we wish to call attention to some of its more important features. The headings of the different sub-divisions are as follows: General Climatic Influences; Physical Features of New York; Temperature; Precipitation; Historical Notices of the Weather in and near New York; Derivation of Temperature and Rainfall Normals. Under the head of "General Climatic Influences" the prevailing winds and the movement and frequency of cyclones and anti-cyclones are considered, as influencing the general conditions of the climate. The section on the "Physical Features" is one of especial value because it presents a clear topographic map of the State, showing the elevations above sea level in contour lines and different shades of coloring. The

physical features are thus made plain, and there is an admirable opportunity to trace out the effects of topography on the various climatic peculiarities. The "Temperature" division includes a consideration of the thermal influence of the ocean and of the Great Lakes; the local peculiarities of the different sections of the State as to temperature conditions, data regarding frosts, maximum and minimum temperatures, opening and closing of navigation in the Hudson, freezing over of Lake Champlain, sleighing across Lake Champlain, opening of navigation in the St. Lawrence River at Ogdensburg, etc.

The section on "Precipitation" includes several curves showing fluctuations of normal rainfall at a number of stations, besides a full consideration of the usual precipitation data. The "Historical Notices" were derived from various sources, and appeared in Blodgett's "Climatology of the United States," and in Smock's "Climate of New Jersey." They furnish a good deal of interesting information in regard to heavy snow falls, freezing of rivers, etc.

Mr. Turner's report is a most welcome contribution to our climatologic literature. It is written in an appreciative style, which makes it easy reading; the charts and curves are numerous and well done; the references abundant and useful. New York is fortunate in having had so competent a meteorologist to work up its climatic data, and in having so admirable a Weather Service to collect them. The publication of such a Report in any State is of value in a great many ways, but surely one of its direct influences is to stimulate the volunteer observers to do more accurate and more appreciative work. The thousands of volunteer State Weather Service observers all over our country are as a whole most faithful and conscientious workers. They take their daily records carefully and punctually, according to the "Instructions" issued by the Weather Bureau, and often go on for years with their task without seeing any definite result of their own individual work except the record of their observations at the end of each month in their local "Monthly Bulletin." Unless some general use is made of their records, as in a climatic account of the State in which they live, many of the observers must inevitably become somewhat discouraged and careless. When, however, a Report such as that of Mr. Turner, for instance, is published and sent to each observer, everyone sees the use of the work he has been doing, is given a larger view of the general subject of climate as a whole, is encouraged to do his work more faithfully, more accurately, and more intelligently.

We learned some few months since that there was a possibility of the abolition of the New York Weather Service, a recommendation to that effect having been made by a Committee of the Legislature. We most sincerely hope that no such step will be taken. If anyone had any doubts as to the work that service has been doing for the State, those doubts must certainly be removed by the publication of the paper on the climate, which we have just reviewed.

THE CONDENSATION OF ATMOSPHERIC MOISTURE.

CARL BARUS. *Report on the Condensation of Atmospheric Moisture.* U. S. Department of Agriculture, Weather Bureau, Bulletin No. 12. 8vo. Washington, D. C., 1895. 104 pp., IV. pls., 27 figs.

This Report is the result of the extended investigation of the conditions of condensation of atmospheric vapor of water, made by Dr. Barus while he was connected with the Weather Bureau as a professor. The field of research which Dr. Barus began to explore is a most interesting and important one, and everyone who has the scientific development of meteorology at heart must sincerely regret that the exigencies of the public service seemed to demand the discontinuance of this work and of Dr. Barus' services in the Weather Bureau. From the preface we learn that the present bulletin is "the mere fragment of an extensive piece of research planned out over two years ago."

The report is a valuable one for students of physics and certain very special problems in meteorology, and will necessarily attract the average student but little. The second chapter of the Bulletin, on "The Colors of Cloudy Condensation," and nearly the whole of the third chapter on "Colored Cloudy Condensation as Depending on Air Temperature and Dust Contents, with a view to Dust Counting," this JOURNAL was fortunate enough to secure from Dr. Barus as original contributions to its pages. The first paper appeared in Vol. IX., 1892–93, pp. 488–521, and the second in Vol. X., 1893–94, pp. 12–34, the cuts used in this JOURNAL being the same as those in the Bulletin.

Dr. Barus' report appears as Weather Bulletin No. 12. We think it a pity that this latest Bulletin should not have been uniform with the preceding ones of the series as regards its external appearance.

INSTRUCTIONS FOR OBSERVERS OF RECORDING INSTRUMENTS.

C. F. MARVIN. *Instructions for Obtaining and Transcribing Records from Recording Instruments.* U. S. Department of Agriculture, Weather Bureau. Circular A, Instrument Room. Revised edition. Prepared under the direction of the Chief of the Weather Bureau. 8vo. Washington, 1894. 40 pp. Tables and figures.

This revised edition of Weather Bureau Circular A, from the Instrument Room, is furnished for the guidance of observers in the preparation of records from recording instruments, and replaces and takes precedence of all similar instructions heretofore issued. The very great importance of having the Weather Bureau records as accurate as possible has led the Chief of the Weather Bureau to issue this new set of instructions, prepared by Prof. C. F. Marvin, of the Instrument Room. The circular is not intended for

the ordinary volunteer observer. It is very complete in its details and gives the most minute directions regarding some matters which, to the ordinary mind, seem of trifling importance, but which, in reality, must be very carefully attended to if accuracy is to be attained. Tables are given of the local time of sunrise and sunset for latitudes 25° to 49° north; of approximate hours of possible sunshine; monthly amounts of possible sunshine for hours ending shortly after sunrise and shortly after sunset, and of depth of precipitation corresponding to given weights.

A BIBLIOGRAPHY OF METEOROLOGY IN THE FIFTEENTH SIXTEENTH, AND SEVENTEENTH CENTURIES.

G. HELLMANN. *Contribution to the Bibliography of Meteorology and Terrestrial Magnetism in the Fifteenth, Sixteenth, and Seventeenth Centuries.* Extract from Report of the Chicago Meteorological Congress, August, 1893, Part II., pp. 352–394. 8vo. Washington, 1895.

Part I., of the Report of the Chicago Meteorological Congress, was issued some months ago as Bulletin No. 11 of the Weather Bureau, and several reprints of papers in Part II., have been sent out. The volume itself has recently appeared.

Dr. Hellmann, being the possessor of a very valuable and a very complete meteorological library, and being a well-known authority on all matters pertaining to the literature of meteorology and terrestrial magnetism, was asked to contribute a paper to the Chicago Congress on fifteenth, sixteenth, and seventeenth century contributions to these subjects. Dr. Hellmann has catalogued the books in his own library only in this paper, but, as he himself says, no meteorological institute possesses the older literature to an equal extent. The works are arranged first by authors, then by subjects, and lastly chronologically. There are numerous notes relating to the different works.

Dr. Hellmann finds that the nationalities of the writers, and the number of each nationality, are as follows: Germans, 67; Italians, 44; French, 29; English, 26; Greek and Roman, 13; Dutch, 8; Spanish and Portuguese, 6; Arabians, 5; Belgians, 4; Swiss, 4; Greeks, 2; Danes, 1; Swedes, 1. The languages in which the books are written, and the number of books in each language are as follows: Latin, 157; German, 37; Italian, 34; French, 21; English, 14; Dutch, 4; Greek, 3; Spanish, 2.

NEW SOUTH WALES RAIN REPORT FOR 1893.

H. C. RUSSELL, F. R. S. *Results of Rain, River, and Evaporation Observations made in New South Wales during* 1893. 8vo. Sydney, 1894. Pp. l, 176. Tables, 2 charts, 2 diagrams.

Mr. Russell's annual volume of "Rain, River, and Evaporation Observations," brings us the extended series of tables which his large number of observers contribute each year. 1893 was a year of abundant rainfall in

New South Wales, the average being ten per cent above the normal. This is not, however, considered "a good year," that expression being used to denote a year with a rainfall of about 30 inches, or 20 per cent above the average. The average rainfall for the whole colony in 1893, was 28 inches, derived from 1,165 complete records.

The report contains a new map showing the average monthly rainfall for each month of the year in each square degree of the colony. The monthly rainfalls are printed in prominent red figures which can be easily seen. There is also a map showing the rainfall for 1893 by means of red circles, the diameters of the circles being proportional to the amount of rainfall. This style of map has been in use for some time in New South Wales, and gives a very striking picture of the amounts of rainfall. The diagrams show the monthly distributian of rain in each square degree for 1893, by means of vertical lines, and the heights of the western rivers of New South Wales by means of curves.

MINNESOTA WEATHER AND CROP REVIEW.

Minnesota Weather and Crop Review. E. A. BEALS, Editor, Vol. I., No. 1. 4to. Minneapolis, May 15, 1895.

This is the first issue of a printed monthly review to take the place of the milliographed reports heretofore issued by the Minnesota State Weather Service. It marks a distinct advance in the usefulness of this Service by placing the climatic information concerning the State in more permanent form and affording a wider distribution for it. In addition to publishing the regular meteorological data for the State from month to month, it is the purpose of the editor to make the "Review" a medium for the diffusion of information relating to the science of the weather in general. The "Review" presents a neat appearance typographically, and in all respects reflects much credit upon the enterprising director of the State Service who assumes its publication individually and without State aid, in addition to his many official duties.

NEW MEXICO WEATHER AND CROP SERVICE.

NEW MEXICO has been added to the list of States and Territories now issuing printed reports. By recent act of the Territorial Legislative Assembly a Weather and Crop Service was established, thus officially recognizing a service which has existed since 1891 under the direction of the National Weather Service. The act also provides for the printing and free distribution of a "weekly weather crop bulletin during the season from April 1 to Oct. 1, in each year, and a monthly report throughout the entire year, contains climatological and agricultural matters of public interest and educational value." An annual report is also provided for. The sum of $700 per annum has been appropriated for printing and incidental expenses. The title of the first issue of the monthly is, "Monthly Review of the New Mexico Weather and Crop Service for the month of January, 1895." H. B. Hersey, U. S. Weather Bureau, Director. 8° Sante Fe, N. M., 1895, 18 pp.

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